The Effects Of Urbanization On The Population Structure Of *Palaemonetes pugio* In Small, High Salinity Estuaries.

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Abstract

Coastal development in the United States has caused significant changes in estuarine ecosystems due to urbanization. High salinity estuaries in the Southeastern U.S. have experienced increased inputs of contaminants from nonpoint source (NPS) urban runoff and decreases in habitat due to filling of wetlands and dock/bulkhead construction. Urbanization may pose significant risks to estuarine fauna, particularly crustaceans. The grass shrimp *Palaemonetes pugio*, is one of the dominant species found in estuarine tidal creeks, accounting for >50% of all macropelagic fauna on an annual basis (Scott *et al*. 1992). *P. pugio* densities were estimated annually at six sites in Murrells Inlet (MI), an urbanized estuary along the northern coast of SC and compared to a reference site in North Inlet (NI), an undeveloped estuary located 30 miles to the south of MI (1993-1994). Additionally comprehensive spatial sampling was conducted during the summer of 1995 at 30 sites in each estuary. Significant ($p \leq 0.05$) reductions in adult *P. pugio* densities were found at MI when compared to NI reference sites in both annual and comprehensive studies. Spatial analytical techniques were used to determine which factors influenced the *P. pugio* populations in MI. Factors investigated included dissolved oxygen (DO), sediment associated Polycyclic Aromatic Hydrocarbons (PAH's), landuse classification, boat docks, and shoreline bulkheading. *P. pugio* densities were affected by presence of urbanized or wetland land use, docks and bulkheads and by DO levels but not PAHs.

Objectives

The goal of this study was to evaluate the effects of urbanization on the distribution of grass shrimp. Specific objectives include the following:

- Determine if adult grass shrimp densities are affected at estuarine sites impacted by urban influences.
- Identify land use activities that influence grass shrimp distributions.

Sample Sites

•Murrells Inlet (MI) is an urbanized estuary along the northern coast of SC sampled at six locations monthly for two years for the temporal survey (Fig. 1) and 30 sites once for the spatial survey (Fig. 2).
•North Inlet (NI) is an undeveloped estuary located 30 miles to the south of MI sampled at one location monthly for the temporal survey (Fig. 1) and 29 sites once for the spatial survey (Fig. 2).
•Temporal sampling sites in MI were selected proximal to urban influences (bulkheading, docks, highways).
•Spatial sampling sites were selected with a randomized grid method to cover the entire estuary and divided into urbanized upland (Murrells-Upland and -Mouth), undeveloped upland (North-Upland), mid-estuary (Mid for both estuaries) and outer estuary (North-Mouth). The sampling time period (mid-July to mid-August) represents one of the three annual peaks in *P. pugio* densities (Wood, 1967; Vernberg *et al.* 1995).

Field Collection Methods

•Grass shrimp were collected using a dip net (3mm mesh x 40cm x 25cm).
•Three consecutive 25m stream stretches at each site were sampled approximately two hours before low tide. The contents from each bank were combined after each tow.
•Adult shrimp (>15mm) were placed in plastic bags and immediately transported back to the laboratory in a cooler where density and biomass were measured.
•Adult densities were compared using a Mann Whitney non-parametric method (alpha=0.05).

Geographic Information Processing Methods

• A vector-based GIS approach was used in this study. Polygon land use coverages of MI and NI were created from National Aerial Photography Program (NAPP) photography using the 1927 data. Florida Land Use and Cover Classification System (FLUCCS) was used to classify each study area.
•Three factors were evaluated relative to grass shrimp distributions. These included:
water quality (DO),
sediment contamination (PAHs), and
proximity to wetland or upland habitat, docks and bulkheading.
• The spatial relationship of the sampling locations and the landuse characteristics was done by assigning one central point for each sample transect at the center of the creek (Figure 2).
• Buffers were created around each sample point origin using the buffering tool in ArcView at increments of 25, 50, 100 and 200 meters (Figure 2).
• The amount of shoreline covered by bulkheading within urbanized MI was measured in early July 1998 by recording the beginning and ending points along the shoreline using a GPS receiver. Points were connected and "best fit" to the existing shoreline of the MI wetland polygon.
• Point coverages of dock locations MI were made from (NAPP) photography.
• Sample sites were classified according to presence or absence of a factor (wetland land use class, docks, or BH) within each buffer distance. Grass shrimp densities for each class were tested for differences using a Mann-Whitney non parametric t-test (alpha =0.05).
• Correlations were calculated using the Spearman's Rank Order Correlation (alpha=0.05).

Figure 1. Temporal Survey Sample Sites and Landuse Classification in Urbanized Murrells and Unurbanized North Inlets. Note Proximity of Estuaries along South Carolina Coast

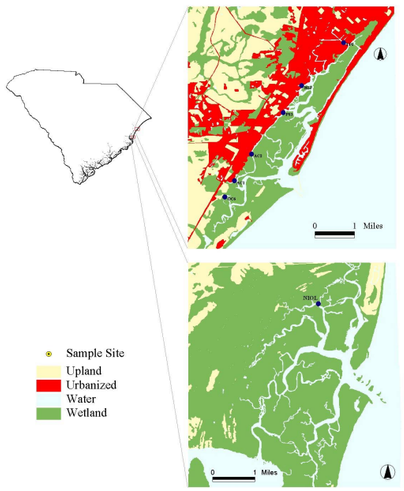
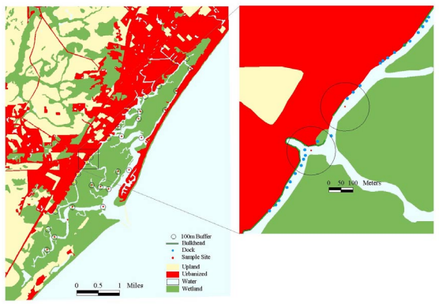


Figure 2. Spatial Survey Sample Sites, Landuse Classification, Bulkheading, and Docks in Urbanized Murrells Inlet. Inset Shows Example of 100 m Radius for Quantifying Urban Factors



Results

•Temporal:
•Densities from average monthly sampling were similar for two years at six urbanized (range 2.02 to 17.1/m^3)and one undeveloped (range 58.6 to 68.6/m^3)site (Fig. 3).
•Densities at urbanized sites were lower than undeveloped sites for two years (Fig. 3).
•Spatial:
•Average estuary-wide grass shrimp densities at undeveloped NI were 149/m^3 (Figure 4).
•Average estuary-wide grass shrimp densities at urbanized MI were 31.0/ m^3 (Figure 4).
•Average estuary-wide grass shrimp densities were reduced (79.2%) in urbanized MI when compared to undeveloped NI (Figure 4).
• Proximity to urban upland class coincided with significant reductions ($p < 0.05$) in adult grass shrimp densities (upland, mid, and mouth) (Figure 5).
DO, wetland within 100 or 200m, bulkheads within 100 or 200m, or docks within 200m were correlated with grass shrimp densities (Table 1).

Figure 3. Temporal Survey Annual (1993 and 1994) Average of Monthly Grass Shrimp Densities at Sample Sites in the Unurbanized (NIOL) and Urbanized (OC-6, AC-1, AC-2, PS-3, MIF, TP-1) Estuaries

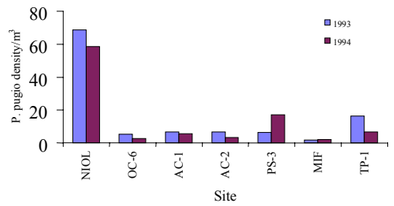


Figure 4. Spatial Survey Average Grass Shrimp Densities for 30 Sample Sites in Unurbanized (NI) and Urbanized (MI) Estuaries

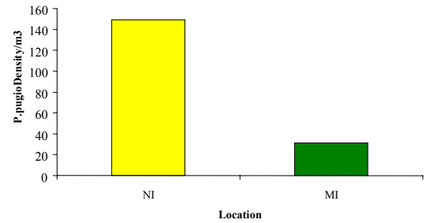


Table 1. Spearman Rank Correlation Coefficients and P-Values of Grass Shrimp Densities Compared to DO, PAH, Wetland, Bulkheads and Docks From Spatial Survey of Urbanized Murrells Inlet.

Parameter	Correlation Coefficient	P-value
Dissolved Oxygen	0.364	0.048*
PAH	0.101	0.593
Wetland 25m	0.000	1.000
Wetland 50m	0.258	0.166
Wetland 100m	0.454	0.012*
Wetland 200m	0.503	0.005*
BH 25m	-0.193	0.303
BH 50m	-0.323	0.082
BH 100m	-0.434	0.017*
BH 200m	-0.416	0.022*
Docks 25m	-0.357	0.052
Docks 50m	-0.243	0.193
Docks 100m	-0.323	0.081
Docks 200m	-0.394	0.031*

* Significant (α=0.05)

Figure 5. Location of Bulkheading, Boat Docks, and Grass Shrimp Densities in Undeveloped North and Urbanized Murrells Inlets From the Spatial Survey. Note Reduced Overall Densities in the Urbanized Estuary and Reduced Levels Nearest Urban Land Classes (Murrells Inlet Upland and Mouth).

Conclusions

•Grass shrimp populations were reduced at urbanized sites compared to undeveloped sites.

•Sites closer to urbanized land classification, within an urbanized estuary, were more impacted than sites away from development.

•Habitat disturbance, such as, bulkheading, docks, and urban land class, reduce grass shrimp densities. These effects were most acute at 100m and 200m.

•Habitat quality, i.e., higher proportions of wetland within 100m and 200m and dissolved oxygen, enhanced grass shrimp densities.

•Further attempts to identify the relationship through modeling should be done.

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